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Optimizing the Internet From the Edges

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BY KEVIN WERBACH

Little by little, the next-generation public Internet is coming into being. Befitting its decentralized structure, the Net is evolving in a distributed way. Projects such as the Internet2 university research consortium and the rollout of broadband connections in the last mile get most of the attention. However, as with a child learning to walk or to speak, the real action is beneath the surface. Our brains slowly accumulate synaptic connections as they learn. Similarly, the Net develops as its constituent networks and their customers upgrade their technology one by one.

Since the Net began carrying commercial traffic, companies have sought better control over traffic flows, bandwidth costs and network performance. A new technology, route optimization, is a major step in that direction. Individual companies can deploy it to enhance their network connectivity. Route optimization and other efficiency-improving techniques such as data compression will foster a more dynamic and reliable Internet. . . which in turn offers hope that network service providers will be able to escape their current death spiral.

With the industry no longer in hyperdrive, a substantial percentage of high-tech startups being funded today are focused on long-term hard problems. These include more efficient information management and pattern recognition (SEE RELEASE 1.0, DECEMBER 2001), which has been the subject of artificial intelligence work for decades; improving network security and robustness (SEE RELEASE 1.0, FEBRUARY 2001); making it easier for people to work together within and between companies (SEE RELEASE 1.0, FEBRUARY 2002);

{ *continued on page 2* }

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The conversation starts here.

and delivering dynamic applications across the Internet (SEE RELEASE 1.0, DECEMBER 2001).

At the infrastructure level, the big challenge is how to fix the Internet without breaking it. The Net doesn't have fancy network intelligence features, because they would make it less flexible for the addition of new services (SEE RELEASE 1.0, MAY 1999). In many cases, throwing bandwidth at the problem turns out to be cheaper and more effective than building sophisticated control mechanisms into the heart of the network.

But there are times when that doesn't work. As the Net becomes more pervasive, reliable, high-speed end-to-end performance becomes increasingly important. Even though the price of bandwidth has plummeted, it's still not zero; mechanisms that use it more efficiently can save companies significant amounts of money.

The area causing the greatest pain is the so-called "middle mile." Companies and broadband-equipped houses have reasonably fast connections to their facilities and within them. At the core of the network, fiber backbones augmented with wave division multiplexing offer massive capacity reserves. The difficulties appear between those elements, whether in the onramps and peering points that link networks together, or in locations such as branch offices and international connections where bandwidth remains scarce.

Route optimization and data compression are two techniques for improving end-to-end network performance that can be implemented at the edges of the Internet. They attack the failings of the middle mile, while leaving the Net's core simplicity intact.

These solutions provide immediate benefits for enterprises and operators of high-traffic Websites. As we discuss below (SEE PAGE 20), they also point the way toward more sustainable business models for service providers.

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Route Optimization

The route less traveled

Network operators and enterprises monitor and tweak their networks all the time to improve performance, whether by adding more bandwidth or by engaging in traffic management to reduce or eliminate congestion points. This has been the first line of network optimization since the early days of the Internet. It is often a costly technique. Moreover, such individual efforts are limited because no one operator has visibility across the entire network. Users care about end-to-end performance, but that may involve links outside the control of the individual organization.

The first wave of alternatives to additional bandwidth involved overlays. They addressed the limitations of inter-domain routing by going around the problem. Such alternatives include inter-network exchange points such as InterNAP (SEE RELEASE 1.0, JUNE 1998) and content-delivery networks (CDNs) such as Akamai (SEE RELEASE 1.0, DECEMBER 1999).

CDNs have become a core part of Internet infrastructure because they can significantly improve performance and reduce bandwidth utilization, especially for high-traffic Websites. They work by serving content not from remote origin servers, but from networks of edge caches closer to the requesting end-user. Peer-to-peer CDNs (SEE RELEASE 1.0, JANUARY 2002) take this model one step further, pushing the caches all the way out to end-user desktop machines, and taking advantage of under-utilized up-stream bandwidth.

Route optimization differs from these other approaches in that it takes existing network configurations as a given. It uses smart devices at the edge of a company's network and within it that can analyze and respond to global network performance. If one route is congested or more costly for the same performance, traffic can be shifted to another route automatically. Sounds simple, but it's difficult to do in practice because of the way the Net works.

Better gateway performance

The reason Internet performance is so unreliable is that the Net is inherently bigger than any one provider. "Internet routing is set up for the convenience of ISPs. It solves a connectivity problem rather than a performance problem," explains RouteScience cto Mike Lloyd (SEE PAGE 8). He continues: "The fact that the net is this patchwork of competitive organizations means that there can't be an over-arching solution for end-to-end performance."

The Internet uses the border gateway protocol (BGP) for routing between networks. Though much less famous than its cousins, the transmission control protocol (TCP) and the Internet protocol (IP), BGP is essential to the functioning of the Net as we know it. Routers at the edge of each network use BGP to communicate with edge routers on other networks. Using BGP, these routers determine which route to send a packet along.

Like most core Internet protocols, BGP was designed to be very simple. The primary algorithm it uses to choose a path for a packet is the shortest route, based on the number of network or "autonomous system" hops. For example, if a packet is going from Arthurandersen.com to ShreddersRus.net, the routing tables may show two paths through intermediate networks to get there.

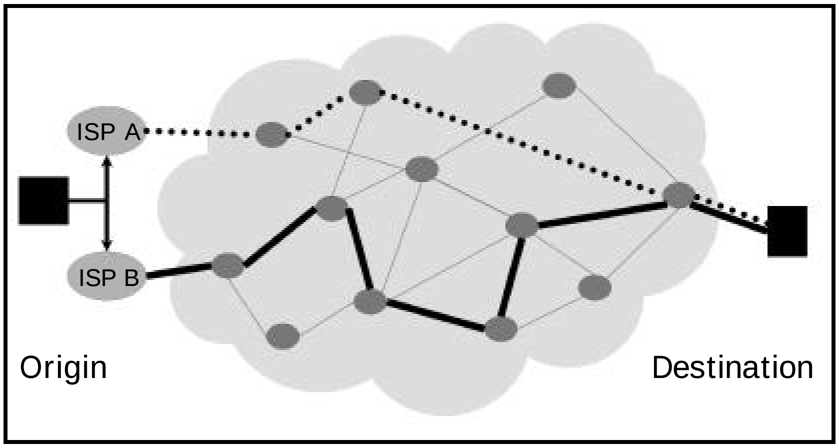

FIGURE 1: *Routing alternatives using multi-homing.*

If one involves six intermediate hops to the destination and the other requires three, BGP will choose the second path. When network hops are equal, BGP uses various manually configured tiebreaker mechanisms. When all else fails, it sends the traffic to the network whose border router has the lowest numerical IP address, originally on the theory that low numbers connote well-established networks likely to have better connectivity.

These simple algorithms, created many years ago, work remarkably well for an Internet that connects tens of thousands of independent networks. Using simple protocols in each router is a more scalable approach than relying on a central monitoring service, which would quickly overload on today's Internet and would be less flexible to boot.

BGP, however, is far from perfect. The shortest number of hops doesn't always represent the best path for traffic to take. If the shorter-hop route is congested, it may actually take *longer* for packets to arrive than it would through the alternate route. Or one route may be shorter but drop significantly more packets. The metrics users care about – speed and reliability – aren't the ones routers directly assess through BGP. Nor is another factor that humans care a great deal about: cost. Finally, BGP treats all packets the same. There's no way to specify business rules to ensure that high-priority traffic takes a more reliable route.

Unfortunately, says Proficient Networks ceo Allan Leinwand (SEE PAGE 7), "this is a problem the protocol wasn't designed to handle." There was always a sense in the industry, he explains, that BGP and other protocols would evolve, but it hasn't happened. The Internet Engineering Task Force doesn't even have a live initiative to add business policy features to BGP.

The inefficiencies BGP causes may not be obvious, but they are significant. Sockeye Networks' Jay Seaton (SEE PAGE 12) explains: "Most enterprises feel that their networks are well-managed, and they assume that since they have top-tier providers, they don't have persistent performance problems. In reality, most companies are experiencing hundreds of significant network events a day that go unresolved because they fall below the radar of being full outages, and they are happening too quickly to effectively troubleshoot and react to."

The route to better networks

Within an enterprise or across a set of cooperating operators, solutions such as Orchestream (SEE RELEASE 1.0, JUNE 1998) allow automatic configuration of routers to match business policies. But they don't function end-to-end across the Internet unless every network operator in the chain has the same system deployed (which hasn't happened). Some newer companies such as Interprovider [DISCLOSURE: ESTHER DYSON IS AN INVESTOR IN INTERPROVIDER], Slam Dunk Networks and CoreExpress have end-to-end solutions for virtual private networks or guaranteed delivery, but that's different from allowing companies to tune their existing network connections as conditions change.

The new route-optimization technologies (often called route control) get around this problem by operating from the edge of one network and measuring performance from there. (In that sense, they resemble instant virtual extranet appliances (SEE RELEASE 1.0, FEBRUARY 2002) though focused on performance rather than security.) They sit outside the data path, so they don't slow down the flow of packets.

Based on proprietary algorithms, they can evaluate different paths and automatically re-route traffic based on business rules set by the customer, overriding BGP.

Route optimization only works for organizations that are multi-homed, meaning connected separately to more than one ISP. Individual companies don't control what happens in the network, but they can switch traffic between physically separate connections for better performance. Once a technique only for the largest enterprises and data centers, multi-homing is becoming increasingly popular as bandwidth demands increase. According to data collected by Opnix (SEE PAGE 14), there are 12,125 multi-homed organizations as of January 2002. Those tend to be large enterprises or heavy bandwidth users, the kind of customers willing to write big checks for networking technology.

Companies have been steadily adopting multi-homing in recent years, with the number of multi-homed sites growing 50 percent per year consistently since 1996. After September 11, many businesses began examining multi-homing for business continuity purposes, to protect against lost connectivity when one network connection goes down. And using more than one ISP also puts companies in a stronger bargaining position as customers, because they can pit the service providers against one another to extract the best deal. "With the economic conditions as they are, there's a natural tendency to have multiple vendors in order to leverage buying power," says NetVmg svp Eric Wolford (SEE PAGE 10).

A Gaggle of Route-Optimization Startups

At a time when venture financing is hard to come by, no fewer than five route-optimization startups have secured funding totaling more than $100 million from well-regarded VCs since early 2001. That's no guarantee of success, but it indicates the potential of this approach to produce real benefits.

The companies, Proficient Networks, RouteScience, NetVmg, Sockeye Networks and Opnix, all use proprietary algorithms to assess network congestion and route traffic accordingly. Sockeye and Opnix follow a service model, charging monthly recurring fees. (Opnix offers a hardware option as well). The other three sell hardware appliances with their software baked in. All of them allow customers to set policies governing the route-selection process, though they differ in the variables they allow into the equation and the services they support on top of the policy functions.

Proficient Networks: lessons from the real world

Proficient Networks' four founders came from Digital Island (SEE RELEASE 1.0, JUNE 1998), the backbone operator and content delivery network acquired last year by Cable & Wireless. Allan Leinwand, who was Digital Island's cto and is now Proficient's president and ceo, says that background is a unique advantage for the new company. "We have 15 years experience running networking in 40-plus countries," he points out. "Lots of people can run networks, lots of people can write software, but not a lot of people can write software to automatically tune networks to run efficiently."

PROFICIENT NETWORKS INFO

Headquarters: San Francisco, CA
Founded: February 2001
Employees: 40
Funding: $6 million from Canaan Partners, El Dorado Ventures and individuals including former Cisco cto Ed Kozel
URL: www.proficient.net

At Digital Island, customers would frequently call and ask that the network be tuned to better support their applications and footprint. And like any good operator, Digital Island proactively monitored and tweaked its own network constantly to improve performance and respond to congestion. Recalls Leinwand: "We had a whole team that did nothing but tune the network manually to meet the business requirements of our customers. Eventually we figured out that we were doing the same things over and over again."

Leinwand and his colleagues started Proficient to automate those route-optimization processes. Based on their real-world experience, the founders concluded that customers would want several options for tuning performance. In addition to cost reduction, Proficient developed algorithms to measure and adjust network performance based on three different criteria: latency, packet loss and jitter. For voice over IP traffic, for example, low jitter is important, but some packet loss is tolerable. For transactions, on the other hand, minimizing packet loss may be critical.

Proficient's customers can set up rules for how traffic is routed based on business needs. For example, ad banners could always go over the cheapest link, streaming media could be optimized for low jitter, and other sites could be equally weighted between latency and packet loss. "In a nutshell, we're making IP a lot more intelligent than it is today," says vp of strategy and marketing Madeline Chan, another of the founders.

Proficient also offers load-sharing, which lets its customers treat the bandwidth on multiple network connections as a single pool. For example, if a company has DS3 (45 megabit-per-second) connections to two ISPs, it could automatically manage bandwidth to keep utilization on each link below 60 percent. Today, companies must move traffic manually between the different connections, and a spike in demand on one link might saturate the pipe even if the other link is relatively empty.

Proficient's products, which currently include a core model and an edge model, are 1U appliances (one unit high, or 1.75 inches, meaning that they take up limited data-center rack space). Each box can handle connections with up to 30 different multi-homed connections to ISPs. "Ours is a standalone, plug-it-in-and-get-it-up-and-running-in-half-an-hour kind of appliance," Leinwand promises.

Leinwand believes Proficient can offer a broader solution than its competitors, because it doesn't limit itself to improving BGP: "We are focused on being the network optimization appliance for all protocols at layer two and three that make routing decisions." Virtual private networks (SEE RELEASE 1.0, FEBRUARY 2002) are one important area where its technology could bring benefits, he says.

Proficient recently partnered with EdgePoint, a Cisco reseller, to incorporate its product into the Cisco Learning Network Architecture for e-learning deployments. Not surprisingly, Leinwand says, customers are looking for a strong ROI. Proficient's devices start at $35,000 for the lower-capacity box and $50,000 for the higher-capacity model, and the company claims payback periods of six months for some customers. "The first hook these days is definitely cost savings," Leinwand notes, "but the second hook that quickly comes involves control, manageability and the fact that this is a very easily deployed product."

RouteScience: the magic pixels

RouteScience's founders came from Cisco, which they joined after the networking giant acquired their previous startup, Netsys, in 1996. At Cisco, recalls cto Mike Lloyd, "We came to understand a lot of the inner details of routing: the ways it doesn't behave as people believe it does." The future RouteScience team realized that many Internet performance problems couldn't be solved with better or faster routers, because they result from basic inefficiencies in BGP and related mechanisms.

ROUTESCIENCE INFO

Headquarters: San Mateo, CA
Founded: December 1999
Employees: 85
Funding: $56 million from Sequoia Capital, Benchmark Capital, Foundation Capital and Sevin Rosen
URL: www.routescience.com

RouteScience uses a unique method to measure network performance. Its competitors analyze actual Internet traffic or send probes through the network to different locations. RouteScience's user traffic test (UTT) technology instead sends special single-pixel GIF images along with existing network traffic, and uses them to understand the performance along different routes.

Virtually every large Website already includes single-pixel clear GIFs for precise object positioning on pages. RouteScience merely serves one of these existing GIFs itself. As a result, UTT usually doesn't add any additional packets to the data flow from the site.

GIFs are delivered through HTTP, the most universal transport protocol on the Net. They go through firewalls and can be used even with sites that serve only non-Web traffic such as streaming media. Moreover, says Lloyd, thanks to RouteScience's unique approach, "We uniquely understand all your alternative paths at the same time in realtime." By sending the single-pixel GIF through a different route from the bulk of the page, RouteScience can compare the actual performance of the current and alternate routes. Without this mechanism, Lloyd says, a route optimization system knows only how the current route is performing. It must take an educated guess about whether a different path would be better.

RouteScience's solution is initially targeted at major "public-facing" Websites, whether business- or consumer-oriented. It has announced B2B auctioneer FreeMarkets as a customer, and like its competitors has others at various stages of implementation that it can't yet name. While some route optimization companies such as Opnix and Proficient Networks went for a low initial price point, RouteScience decided it would have an easier time miniaturizing the components of a high-performance box than trying to scale up a device designed for the mid-market. Its devices run from about $100,000 to $250,000. "We've built a solution for the largest, most challenging. . . and most lucrative Web presences," notes Lloyd.

The company believes that customers, especially at the high end, want total control over the way route optimization is implemented in their networks. The RouteScience box functions like other pieces of gear customers already have, and the customers can configure it to meet the specific needs of their networks. Notes Lloyd: "People who manage networks understand that they're not interested in an optimized Internet. They're interested in optimizing *their* part of the Internet."

Not surprisingly, Lloyd takes issue with the Sockeye and Opnix approaches (SEE PAGES 12, 14) of setting local routing policies based on global Internet performance data. "The notion that somebody else's map of the Internet could be described to you quickly enough so you could get value out of it is not sensible," he comments.

Today, RouteScience's customers are often most interested in finding better ways to manage their bandwidth costs and stay within their budgets. They use expensive "tier 1" providers simply because they can't risk something going wrong. Using route optimization, these companies can minimize the risk of traffic slowdowns, while routing much of their traffic over low-cost providers.

In the future, Lloyd sees RouteScience extending its technology to VPNs and eventually to improving other inefficient functions at the edge the network. Load balancers, domain name servers and application-specific devices all could benefit from intelligence about routing alternatives.

NetVmg: tacking into the wind

NetVmg was founded by Jeremy Johnson, an engineer at Excite@Home, and Global Crossing peering expert Allan Hannan. "What seemed obvious to them was that you could take intelligent use of diversity as an alternative to capacity," explains svp of business development, sales and marketing Eric Wolford. In other words, instead of adding bandwidth to address congestion, route around the congestion on an alternate ISP link.

Coming from service-provider backgrounds, NetVmg's founders initially developed their route-optimization solution as an outsourced service for companies seeking more predictable Internet performance. Potential customers, however, were reluctant to entrust their bandwidth to a startup, and balked at NetVmg's substantial recurring charges. So the company retooled and packaged its technology as a product. Ceo Samer Salameh, whose background as ceo of Prodigy was more suited to a service company, departed. He was replaced initially by one of NetVmg's investors, and more recently by Alan Robin, former svp of sales at CacheFlow.

NETVMG INFO

Headquarters: San Jose, CA
Founded: May 2000
Employees: 57
Funding: $67 million from Accel Partners, Duff Ackerman & Goodrich, Comdisco Ventures, Bank of America and McQuillan Ventures
URL: www.netvmg.com

Despite the business-model shift, NetVmg hasn't strayed far from its roots. "Network engineers tend to like our solution because it was designed by network engineers," says Wolford. The company's advisory board includes prominent networking experts such as LoudCloud svp and former GlobalCenter cto Jonathan Heiliger, IETF protocol expert Vern Paxson and Yakov Rekhter of Juniper Networks. In addition to selling its product directly, NetVmg has partnered with Equinix, which operates large neutral exchange points where networks come together to exchange Internet traffic. Equinix sells route optimization based on NetVmg's technology as a value-added service.

The company name is a sailing reference. VMG, or velocity made good, is the effective speed to the mark of a boat forced to tack back and forth into the wind to get there. NetVmg sees itself enhancing companies' real end-to-end network performance by "tacking" between different ISP connections.

Though NetVmg offers cost savings and other benefits, Wolford says what potential customers want most is control. Their applications and business objectives are varied, but they all crave predictability. Wolford elaborates: "It isn't so much, 'make the Internet better from an average performance expectation', but, 'make it consistent'. Route control serves as a shock absorber to the unpredictability of the Internet. . . and to your income statement."

Peak performance

At the same time, cost remains important. Sony Online Entertainment, a NetVmg customer, says it has seen a 20 to 40 percent savings on bandwidth costs thanks to the product. The savings come from three sources: using the low-cost provider more often because performance is now measurable, cutting down on overprovisioning of bandwidth, and concentrating demand peaks on the same provider.

The last scenario isn't entirely obvious, but can be significant. Peak demand is what drives bandwidth costs: you pay for what you need at the busiest time. But demand spikes vary for different applications and types of traffic. If connection A sees a peak of 10 megabits per second (Mbps) demand at 10 am, and connection B has a similar peak at 8 pm, the customer will need two 10-Mbps pipes. But if that traffic is consolidated on connection A, the second pipe can be smaller.

In order to address these sorts of inefficiencies, Wolford says, the route optimization solution must be able to plug into existing billing structures. ISPs rarely price bandwidth as a simple flat rate. A common pricing model is to offer tiered levels of bandwidth, with a minimum commitment and a higher "burstable" amount. This way, companies pay the same amount regardless of usage up to a certain point, but can use more bandwidth at peak times at a higher price.

However, burstable pricing means that which route is cheaper may depend on how much bandwidth a company is actually using relative to its contract with the ISP. NetVmg addresses this by incorporating billing structures into its policy models, so that it can analyze route-control decisions in terms of marginal costs and benefits.

NetVmg looks at actual network traffic for its performance measurement, rather than using probes or samples. Customers can configure the time window the system uses to look for and react to congestion, depending on their network usage.

Wolford sees route control as an indication of the value of a separate “control plane” for Internet traffic, similar to the telephone network’s SS7 network. We discussed this model in our analysis of CDNs (SEE RELEASE 1.0, DECEMBER 1999). Just as the SS7 network in the voice world made possible sophisticated call-routing services, Wolford believes, out-of-band route optimization will eventually allow for new Internet-based services that depend on intelligent and dynamic traffic flows.

Sockeye Networks: storm watch

Sockeye Networks is a spinoff of Akamai. It uses a service model for route optimization, based in part on Akamai’s realtime network performance data. Akamai has more than 13,000 edge servers on 1,000 networks in over 60 countries. By monitoring the performance of those servers, Akamai is able to glean a unique snapshot of overall worldwide network performance. Sockeye leverages that data in two ways: into what ceo Valeri Marks calls a “storm watch capability” to understand Internet performance, and to track the Net’s constantly changing topology.

SOCKEYE NETWORKS INFO

Headquarters: Waltham, MA
Founded: Fall 2000
Employees: >60
Funding: $28 million from Baker Capital, Battery Ventures, CSFB and Polaris Ventures
URL: www.sockeye.com

Sockeye’s original agreement with Akamai called for substantial monthly payments, raising questions about whether Akamai was using the Sockeye revenue to artificially boost its bottom line. Last fall, Sockeye and Akamai restructured their agreement, shifting to a revenue-sharing model with only nominal monthly charges.

The benefit of Sockeye’s unique approach, Marks says, is that it can proactively assess the performance of prospective network paths from a customer. “When we move their traffic, we know it’s a better-performing link,” she says. Though the hardware- and software-based route optimization solutions also identify congestion, they must do so blindly from the customer location, explains Marks. They can react to congestion, but not anticipate it. “When you’re trying to test and do your metrics, you need to know the right places to test to,” she says.

Sockeye combines the Akamai “storm watch” data with local information about its customers’ network connections, in order to determine which points to measure to and to recommend the best routes in a particular situation.

Sockeye also started out by offering route optimization as a service. “A service adds the advantage of 7x24 support,” Marks points out. “Route optimization is a brand new category.” Customers don’t necessarily have the in-house expertise to take full advantage of a route control solution. Moreover, Marks says, “We think a service model is more scalable and minimizes the technology risk.”

From reactive to proactive network management

“There’s a great opportunity to fundamentally change the way networks are managed, where route optimization becomes very standard with multi-homed networks,” Marks argues. As the ability to change routes dynamically becomes more common, network managers will think more proactively rather than simply reacting to crises. For the future, Marks says, Sockeye is looking at delivering more sophisticated tools for cost-based routing and management of service-level agreements, giving companies greater visibility into their network connections.

Chief marketing officer Jay Seaton says Sockeye’s initial customers include high-traffic Websites that need large amounts of bandwidth and service providers looking to differentiate themselves. As enterprises deploy more mission-critical applications over the public Internet, such as videoconferencing, they will also need better means to ensure reliable network performance. The increased concern about security and reliability after September 11 is also pushing more enterprises in the direction of multi-homing, making them candidates for route optimization solutions.

“We find that sometimes companies out there don’t even realize how poorly their networks are performing today,” notes Marks. Major outages are hard to miss, but companies are often unaware of more-frequent network hiccups or slowdowns that have a real effect on their business. “Companies don’t realize the pervasive nature of underlying problems that are constantly going on beneath their radar,” says Seaton. For one customer with three ISP connections, Sockeye found that BGP selected the optimal path only 20 percent of the time, whereas Sockeye did so 95 percent of the time, leading to a significant performance improvement.

Ethernet creator Bob Metcalfe, Genuity chief strategy officer Jim Freeze and Akamai chief architect Avi Friedman are Sockeye advisors; Akamai ceo George Conrades (SEE RELEASE 1.0, MARCH 2000) and chief scientist Tom Leighton sit on its board.

Opnix: the best of both worlds

Opnix delivers route optimization through a hybrid model. Instead of selling an expensive appliance, it puts a relatively simple device at the customer data center that primarily does data collection. This device, the Orbit 1000, sends the data over the Internet to Opnix's central optimizing route engine (CORE), which aggregates it with data from other customers and performs the route optimization analysis centrally. At selected intervals, Opnix populates the customer's router with optimized routing tables.

OPNIX INFO

Headquarters: Tempe, AZ
Founded: December 1999
Employees: 17
Funding: $8.35 million from
  eStreetCapital and Garage
  Technology Ventures
URL: www.opnix.com

Because of its approach, Opnix can charge a lower initial price than appliance-based competitors such as Proficient, NetVmg and RouteScience. The heavy lifting and computing power is shared across many customers. Opnix's pricing starts at $20,000 up front and $1,000 per month for the ongoing service. "We're looking at this as a business problem, not a pure technology issue," says Opnix vp of sales and marketing Rajeev Arora. Customers want to focus on their own businesses, he explains, not maintaining a new piece of hardware or managing network performance analysis in-house.

If customers want, however, Opnix will also sell them their own local CORE hardware and software. The company believes it can still undercut competitors' prices, because one CORE device can serve all a customer's data centers, instead of each data center needing its own appliance.

At its data center, Opnix runs a cluster of Linux machines and a terabyte storage array. It can generate routing recommendations for each customer based on its own data, but, adds Arora, "as you start adding more customers, the whole thing gets incrementally more intelligent." By crunching the data, Opnix generates a realtime view of overall Internet performance. This "weather map" resembles the Akamai data that power Sockeye (SEE PAGE 12), but Opnix believes data specifically collected for route optimization purposes based on customer's actual network usage will generate superior results.

"When you talk to customers, they say, 'We don't want to make decisions based on Akamai's network; we want to make decisions based on *our* network'," explains Arora. Most of Akamai's information is derived from static content, he adds, whereas route optimization customers are often sending streaming media, voice over IP or transactional application traffic.

Opnix's model creates additional business possibilities as well. "Getting all that performance data back centrally means you can use it for many other purposes," says Arora. "We probably know more about the carriers' networks than they do." Though today it is focused on selling route optimization, Opnix could in the future offer network operators services to help them configure and manage their networks. It also has a partnership with the Internet2 consortium to develop new uses for the data it is assembling.

The company was founded in 1999 as a network service provider, using route optimization to deliver high-performance connectivity. It signed up several customers before realizing, as the bottom fell out of the tech market, that the economics of running a network didn't make sense.

Last year, Opnix retooled itself to provide solely the route optimization service, not the underlying bandwidth. It hired current ceo Jane Evans, who previously ran US West's residential phone business, last May 2001. Evans sits on the boards of Philip Morris and Georgia Pacific; she saw how large enterprises were struggling to manage their Internet connections because they couldn't ensure reliable performance without massive over-provisioning.

Opnix is substantially smaller and has raised less venture financing than its competitors, though nowadays those facts may be advantageous. The company has "about half a dozen" pilot customers for its service, which it isn't yet prepared to name. Most are service providers, including ISPs and a virtual private networking company; one is a financial-services company.

Squeezing Network Traffic

An alternative means to improve network performance is to reduce the amount of data that flows across the wire. This is essentially how caching solutions, including standalone caches and CDNs, improve performance. They serve as much content as possible locally, reducing the volume of data that must be sent across the network.

Caches have their limitations. They help only when content is already in the local cache, either because a previous user has requested it or because it has been pre-populated by the network administrator. As a result, they are less effective in situations involving dynamic or personalized content, which is becoming increasingly prevalent on the Net. Moreover, caches often require content to be specially tagged, and they are usually limited to Web traffic.

Data compression is the next step beyond caching, reducing the amount of traffic sent across the network to a substantially greater degree.

The basic idea of data compression applied to networks is hardly novel. However, traditional compression techniques are useful only for limited circumstances and low-speed connections, due to their processing and latency requirements. Peribit and FineGround Networks break new ground with unique approaches. Peribit employs algorithms derived from bio-informatics to uncover patterns of redundant traffic at the byte level. FineGround uses several higher-level mechanisms to eliminate redundancies, even for personalized or dynamic content.

Route optimization and data compression are complementary technologies. Each provides certain benefits, and they can be used together. As Peribit founder and cto Amit Singh explains, "We are in the business of reducing the amount of data, and they are in the business of routing the data better."

Peribit Networks: cracking the network genome

In recent years, information technology has transformed the life sciences. Efforts such as the Human Genome Project wouldn't be possible without massive computational power. An entire new field, bio-informatics, has evolved to cover the application of computing to biology.

PERIBIT INFO

Headquarters: Santa Clara, CA
Founded: May 2000
Employees: 40
Funding: $31 million from Accel, Foundation Capital and Mayfield
URL: www.peribit.com

At the same time, there is a parallel move in the opposite direction. With the development of complexity science (SEE RELEASE 1.0, APRIL AND MAY 1992, JUNE 1989), biological concepts are being fruitfully applied to technology. In security, for example, Company 51 (SEE RELEASE 1.0, MARCH 2002) is using techniques derived from the human immune system to build better anomaly detection software. Living Systems (SEE RELEASE 1.0, SEPTEMBER 1999) uses agent technology for dynamic negotiation of everything from prices to supply chain interactions. [DISCLOSURE: ESTHER DYSON IS AN INVESTOR.] Neural nets are commonly used for fraud detection/prevention by companies such as HNC Software and are also widely applied for text analysis (SEE RELEASE 1.0, DECEMBER 2001).

Peribit is the first example we've seen of a round trip between life science and IT.

Singh was completing his PhD research at Stanford on computational molecular biology when he started Peribit. His work involved developing pattern-recognition algorithms. Human DNA is an exceedingly long thread composed of varied sequences of just four bases (distinct data elements), called nucleotides. Genes are encoded as patterns within the DNA string, alongside vast amounts of non-functional "junk" DNA. The challenge of genomics is to extract and make sense of those patterns. Given the volume of data, automated techniques are essential. Similar pattern-recognition challenges appear in other areas of molecular biology today.

"Pattern recognition is a valuable tool for deciphering data when you don't know what the data means," says Singh. During the course of his work, he realized that the algorithms he was developing could be applied beyond biology. Complexity research has shown remarkable similarities between the behavior of complex systems in different domains. In particular, data traffic on computer networks exhibits some of the same features as bases in DNA. "We found that in general network data tends to be highly redundant," explains Singh. So he and his team modified their algorithms to find repeating patterns in network traffic, down to the byte level.

Once redundancies in network traffic are identified, they can be eliminated by replacing each instance with a much shorter code. This is what file-compression techniques such as the ubiquitous Zip algorithms do for individual files. Peribit's molecular sequence reduction applies the same approach to realtime network traffic, and it does so using much more efficient algorithms.

Peribit incorporates its software into rack-mounted appliances that are deployed in pairs (or in a one-to-many configuration) across network links. One appliance monitors traffic, identifies patterns and encodes the data in compressed form. The appliance on the other end decodes the data, returning it to its original form. All this happens in realtime, and the benefits can be substantial. Peribit's tests show bandwidth savings of 70 to 95 percent, depending on the type of traffic.

The level of redundancy in network traffic shouldn't be surprising, Singh points out. Caching is widely used throughout the Internet because the same objects, such as ad banners or popular Web pages, are requested many different times. As Singh explains: "We thought if that's the case at the file and object level, what if we went down to the lowest level of the network and looked at it at the byte level? Would there be the same level of repetition? Clearly, the answer is yes."

Low-level pattern-recognition

Peribit's appliances know nothing about the content of the traffic they analyze; they look for any patterns in the raw packets streaming across. As a result, they can pick up patterns across applications that higher-level techniques such as caching miss.

Because it operates on the traffic itself, Peribit's technology can work alongside other mechanisms such as route optimization. Its limitation is that it requires a box on both ends of the connection. In contrast to the route-optimization tools, Peribit's appliances can't be dropped into a single location in the network.

One significant market is in corporate networks connecting many locations, especially when some of them are in areas where bandwidth is expensive or hard to come by. The customer can deploy one Peribit box at its main location, and another at the other ends of the limited pipes. Singh says the company has seen initial demand from customers in industries with significant international operations, including high-tech, oil exploration and financial services. Typical ROI is three to 11 months, he says, but can be on the order of weeks for expensive international links.

Peribit is now concentrating on improving the ease of integration between its devices and customer networks. "There's no such thing as a typical network," says Singh. The company's technical team is also further refining the core pattern-recognition algorithms, to take into account a wider array of real-world situations. Though Peribit's products today are hardware appliances, the company's core IP is in software that could theoretically run anywhere, including boards and chips.

The company is making the transition from a technically focused startup to a business that engages with customers. Former 3Com svp Jef Graham joined Peribit as ceo in September. Initial customers include Finisar, Chevron and BroadVision.

FineGround Networks: the delta-finders

"The fundamental idea of our technology is to send only what's changed," explains FineGround ceo Nat Kausik. Kausik previously founded Web security company Arcot; he joined FineGround after spending time as an entrepreneur-in-residence at New Enterprise Associates.

Over the past several years, Kausik notes, more and more companies have migrated their applications to the Web, and even consumer-oriented Websites have become increasingly personalized and dynamic. That means many of the Internet performance-enhancing techniques now in use won't be as effective going forward. "Caching was first deployed for consumer content, but it doesn't do anything for enterprise content, which tends to be dynamic, personalized and encrypted," he explains.

To address this non-cacheable traffic, FineGround created a new solution from scratch. "There was no well-understood way to do this without a browser plug-in or changing the HTTP protocol itself," Kausik says. FineGround's software runs in the data center, behind the firewall and close to content origin servers. It requires no changes to the servers or to browsers. Moreover, unlike Akamai, applications need not be modified to tag content for caching.

FINEGROUND INFO

Headquarters: Campbell, CA
Founded: 2000
Employees: 25
Funding: $21 million from New Enterprise Associates, Worldview Tech Partners and individuals
URL: www.fineground.com

FineGround's technology, which is calls condensation, actually involves five different techniques. Delta optimization determines in a fine-grained way which page elements have changed and which are already in the local browser cache. Object acceleration eliminates unnecessary version-control validation requests to the server by embedded objects on a page such as images or Javascript. SSL offloading handles secure connections, used in situations such as e-commerce, more efficiently than the built-in browser mechanisms. Server connection offloading creates a persistent connection with Web and application servers, analogous to realtime messaging buses (SEE RELEASE 1.0, DECEMBER 2001). Finally, it applies standard data-compression algorithms to whatever content is sent to the browser.

An important technical achievement of FineGround's solution is that the company is able to track what is already in each browser's cache without having to store a complete database of every browser cache on the server side.

FineGround claims up to a ten-times performance improvement and a 95 percent bandwidth savings. It recently commissioned a study by a consulting company that documented reductions in this range under certain circumstances. The exact improvement depends on the speed of the user's connection, the type of content involved and whether the user has previously requested the same content.

"What we're really offering our customer is an ability to unlock the value of the investment they've made in enterprise Web applications," declares Kausik. Companies have spent so much money on networking and applications such as portals and customer relationship management that today they are looking to make better use of what they already have.

FineGround now has ten customers, including Charles Schwab, Multex, Swissair, Keen.com, Whirlpool and Sun. Its product, now in version 3, is available on both Linux and Solaris. In May it plans to roll out version 4, which adds additional acceleration features on the server side. The new version will address delays caused because of server capacity and latency problems, in addition to speeding performance between the server and the end-user.

Business Benefits

Why optimize?

The salient aspect of route optimization and data compression today is that they deliver a solid return on investment. Bandwidth is a substantial cost, and one that can be measured. Reducing bandwidth usage delivers hard-dollar benefits that are straightforward to count. That's what enterprises are looking for today, and investors as well.

Yet with the cost of bandwidth falling rapidly and a glut of capacity on fiber backbones, is optimization even needed?

It's true that most of the potential long-haul fiber capacity put in the ground in recent years isn't being used. It's also true that competition and technological improvements have substantially reduced bandwidth costs. For enterprises, however, demand for bandwidth has scaled as fast as prices have come down. Dark fiber between cities isn't the same thing as end-to-end capacity across the Internet; the latter remains expensive.

Moreover, route optimization delivers more than lower costs. Choosing efficient routes through the public Internet enhances performance and reliability, which in many cases are more important than price. Most large enterprises knowingly overpay for connectivity to ensure that mission-critical services have sufficient quality of service guarantees. Route control allows them to get those benefits without paying for expensive capacity they don't need. But it also allows them to monitor and manage performance more effectively than they could before, because for the first time they can view end-to-end performance from the edge of the network.

Pricing dynamics

As David Isenberg and David Weinberger explain in "The Paradox of the Best Network" (SEE RESOURCES), there is a downside to the Internet's marvelous end-to-end architecture. Separating basic connectivity from higher-level applications and services, which are defined at the edges of the network, enables substantial innovation and creates a vibrant industry. But it leaves the network owner in the position of delivering a commodity. End-users and downstream service providers may love a scenario of ever-declining prices and margins for basic connectivity, but that's not likely to make the connectivity provider happy. And Wall Street has a way of demanding fat margins and profits.

The idea that network owners can't make money in the Internet model is behind efforts such as the Tauzin-Dingell bill that would make it easier for local telephone companies in the US to exclude competitors from their data networks. Cisco vp of Internet switching and services Mike Volpi made a similar point at PC Forum last month. He argued that connectivity always had been subsidized by applications before the Internet. If we want broadband, the argument goes, network owners such as telephone and cable companies need incentives to expend the necessary capital. And they won't have enough incentives unless they can capture the full revenue stream from their investments.

There are flaws in these arguments, particularly in the assumption that vertically integrated business models are necessarily the most successful. We addressed that question in our analysis of open access (SEE RELEASE 1.0, FEBRUARY 1999) and our discussion in previous issues of other policy questions regarding broadband (see RELEASE 1.0, FEBRUARY 2002 AND JULY/AUGUST 2001).

The issue here is whether the fundamental assumption about commoditization need hold true. It need not.

As long as connectivity is all-or-nothing, it's a fair question whether anyone can build a successful business devoted to delivering it. We note in passing that Dell does pretty well in the "commodity" PC business, and Wal-Mart has found a way to succeed in commodity retailing. Even if we take as a given that commodity bandwidth delivery is ultimately unprofitable, there is an alternative.

A bit isn't always a bit, any more than an airline seat is just a seat. Some people will pay more for certain features, and under the right circumstances, some people will pay more for *the same* features, with appropriate guarantees (SEE RELEASE 1.0, MAY

1993). Networks should work the same way. Organizations and ultimately individual end-users should have a spectrum of choices, so that they can make decisions about what they are willing to pay for. Enabling that capability, however, traditionally meant building something into the fabric of the network, whether policy routing at every exchange point (SEE RELEASE 1.0, JUNE 1998) or overlays such as CDNs. And that risked undermining the end-to-end flexibility of the Net.

With route optimization, customers for the first time can see directly into the end-to-end performance of their network connections, and can trade off factors based on business needs. The solutions discussed above enable such intelligence from the edges of the network. They point toward an environment in which service providers and network operators have many more options to manipulate to assemble a workable business model. In other words, we're moving toward global knowledge, even while retaining local control.

This doesn't necessarily mean every service will be fine-tuned to a different performance level, with an accompanying difference in price. It also need not mean the wholesale creation of a virtual digital divide between a non-functional best-efforts Internet and a pyramid of increasingly expensive and well-performing options. Service offerings still must match up with what customers are willing to pay for, and how they are willing to pay for it. The supply and demand sides of the equation will intersect at many points.

Because bandwidth requirements keep growing even as capacity increases, there will always be a need for efficiency-enhancing techniques on the Internet. In the Net's next phase, those techniques will become more automated and will allow for policy-based configuration. Slowly but surely, the Net evolves. ■ R 1.0

The New WWW

BY KEVIN WERBACH

Listen carefully. The old grassroots energy is coming back. Web services, Weblogs and WiFi are the new WWW.

One way to gain a long-range perspective is to look at what gets the early adopters excited. Passion among users and developers is important for the growth of any new technology. Sometimes that passion links directly to business opportunities and wealth creation. Other times technologies incubate among hobbyists and hackers, motivated by the pure joy of creativity and connectedness, until they find commercial outlets. (SEE TIM O'REILLY'S ARTICLE CITED BELOW IN RESOURCES.)

The Web, after all, captured the imagination of technologists, especially of the younger generation, long before it was seen as the basis for a financial boom.

Three forces came together around 1993 to lay the groundwork for the Web explosion. End-user tools, in the form of the browser and HTML, drastically lowered the barriers to reading and especially to posting or linking to content on the global data network. A set of server protocols, including HTTP and TCP/IP, lowered barriers to making that information universally available. And a new form of connectivity, dial-up ISPs, expanded the universe of people who could participate in the online world beyond the earlier proprietary online services. Together, these developments comprised the World Wide Web, or WWW.

Today, we have three new W's. They extend and deepen the Web, rather than replace it. We've written about all three over the past year, but it's worth offering a brief update to explain what they mean in concert.

The Gang of Three

Web services

In remarkably short order, the IT industry has coalesced around a standard set of protocols and approaches for linking applications and software components (SEE RELEASE 1.0, SEPTEMBER AND OCTOBER 2001). For enterprises, Web services mean incrementally better application development, integration and management over a period of several years, as tools, templates and techniques are developed and enhanced. There are real problems to be solved. . . but addressing them requires real enterprise-class solutions, which don't appear overnight.

But there's another side to Web services. The size of the market around this new architecture is almost beside the point. Take Legos. What's great about them isn't that the Lego Corporation has a good business model. Or to be precise, that's not the *only* thing good about them. It's important, but starting there is putting the cart before the horse. The beauty of Legos is that any child (or adult!) can sit down and build something with them.

Web services (properly implemented) are the Legos of software. Lower the bar for creating new services and for re-combining existing software elements, and something wonderful is bound to emerge sooner or later. Thousands of developers are poking around with Web services, especially with the introduction of relatively easy-to-use tools such as Microsoft's Visual Studio.Net and BEA's Cajun. Days after Google added an XML API to its search engine, developers had created dozens of experiments, including interfaces to email and instant messaging. Amazon.com now offers an XML interface as well, which should provoke similar activity.

Developers could pull data from Google and Amazon before using scripts and screen-scraping technologies. Those, however, are brittle and usually require technical sophistication. By analogy, desktop publishing existed before PageMaker, but everything changed when there was as an easy-to-use tool. Web services mean that networked applications are going to be open in ways they never were before.

Weblogs

Weblogs (SEE RELEASE 1.0, MAY 2001) give anyone who wants it a new means for personal expression via the Net. They promise to complete the revolution that HTML and Mosaic started. Millions of people around the world have created homepages and other sites on the Web. That outpouring of personal publishing brought countless others online, formed the foundation for successful businesses such as GeoCities and Vermeer, served as a gateway to commercial sites and set in motion changes in the way we interact with information.

However, most home pages are static. Updating them is a chore, and they are tied to a particular URL that users must visit. Commercial Websites began to experience these problems years ago. The solution came to be called content management.

Automated tools replaced hard coding, and database-driven technologies turned sites into more dynamic collections of components.

Weblogs do for personal sites (which may also be commercial, as with pundits such as Andrew Sullivan and Micky Kaus) what content management did for corporate sites. They make it simple to add, modify and distribute content dynamically. This is why, despite the limitations of the available tools, Weblogs have taken off so dramatically among leading-edge users. The leading commercial Weblogging tools, Blogger and Radio Userland, have improved over time, though they still aren't as polished as applications such as FrontPage and BBEdit that drove the first wave of Web publishing. Intriguingly, both Blogger and Radio Userland incorporate Web-services elements, making them even more powerful.

WiFi

Unlicensed wireless services (SEE RELEASE 1.0, NOVEMBER 2001) open up connectivity. Anyone can connect to a WiFi wireless LAN with a card costing less than $100 (or built into many laptops such as Apple's Powerbooks). A reasonably sophisticated user can create his or her own home network with an access point costing under $200. And collectives or individuals or small-scale businesses can establish free or commercial public access points almost anywhere.

There's something liberating in the idea that users are taking control of the airwaves, just as dialing into an ISP once felt like a subversion of the dominant telephone companies over whose networks the connections operated. WiFi's IEEE 802.11 protocols started as mechanisms for corporate wireless LANs, but as equipment has become cheaper and more prevalent, new uses have sprung up. And we're only down the early stages of that curve. New enablers such as Joltage, Boingo and Sputnik (SEE RELEASE 1.0, MARCH 2002) should allow for even greater experimentation.

At this year's PC Forum, WiFi and Weblogs came together to produce some of the most memorable moments of the conference. One speaker faced a hostile crowd because a reader on the Net, not even at the conference, emailed in a comment to a journalist posting session notes to his Weblog. In another session, the panelists on stage responded directly to a Weblogger in the audience, turning the traditional conference one-way communication model upside down. Esther detailed these events in our email newsletter, *The conversation continues* (SEE RESOURCES). It's hard to imagine an executive technology conference now that doesn't offer a wireless back-channel.

Tapping Communal Energy

The barriers fall

What all three developments have in common is that they lower barriers to communication, just as the Web did. And they may not be alone. File sharing and community-oriented music services such as playlist swapping would be on the list as well, if it weren't for the unresolved legal issues surrounding licensing and copy protection (SEE KEVIN KELLY'S ARTICLE CITED IN RESOURCES). The power of people using technology to connect to one another cannot be over-estimated. That's the lesson of ICQ, Napster, the Cluetrain Manifesto and too many other examples to count.

The original Web made it remarkably easy to publish content and build applications for a global user base. At the core, though, those sites were often brittle. Even with graphical tools such as FrontPage and DreamWeaver, individuals have a hard time keeping their Websites updated and adding dynamic features. Enterprises are finding that, after pouring large sums of money into Web-based systems, including integration solutions, making changes and getting elements to talk with one another remains difficult. And high-speed, always-on connectivity is far from ubiquitous.

The new WWW makes software, content and connectivity into resources that may be shaped and combined into new ways. Of course, doing so still requires technical skills and there are plenty of implementation hurdles in the real world. But it's possible to experiment where it wasn't before. . . and that makes all the difference.

The three new W's all have openness and critical mass going for them. They are built on standards, and have managed to gain the support of large platform vendors and independent developers alike. Not to say there can't be other elements of the next-generation Web.

Macromedia, for example, is pushing hard with its recent Flash MX release to be the standard for post-HTML dynamic Web-based applications. Flash is a proprietary technology, but it's so widely installed that it counts as a *de facto* standard. Despite a similar scenario, Java failed to become a popular mechanism for client-side applications, even as it became dominant on the server. Macromedia, tapping the technology and developer-evangelism expertise it acquired with Allaire, thinks it can succeed where Sun failed. To do so, it will have to win over the grassroots.

Yes, but is it a business?

The far-out experiments and eureka moments of hard-core technologists don't constitute a mass market, and the early labors of love aren't always a reliable pointer toward later commercial solutions. So let's be clear: Web services, Weblogs and WiFi are exciting today more as technological phenomena than as reliable guides to business success or market trends. We've covered startups in each of these areas. Those startups' success may be a good confirmation of the significance of the broader sector, but their failure won't mean the opposite. "Online community" ventures (SEE RELEASE 1.0, JUNE AND JULY 1993) have had at best mixed success in recent years.

Nonetheless, communal energy should not be ignored. As Malcolm Gladwell described in his book, THE TIPPING POINT, a small number of plugged-in connectors can have a disproportionate impact on mass-market trends.

At every major turning in the computer industry's evolution, new platforms and applications have captured the imagination of sophisticated users by offering unprecedented freedoms. Shortly thereafter, others used those advances as the foundation of lucrative businesses.

Unix was a powerful, flexible and (in theory) hardware-independent platform for developing applications on workstations. Sun (among others) fed off that energy and built a multi-billion-dollar business. The spreadsheet allowed businesspeople to model and forecast to their hearts' content. It also allowed Mitch Kapor and his colleagues to create Lotus. The graphical user interface gave computers to "the rest of us. . ." and propelled the rise of Apple and then Microsoft. The Web let anyone publish to a global audience, at first piquing the interest primarily of academics and geeks, but later bringing us Amazon, Yahoo!, eBay and more.

Outlines of a model

More specifically, the early developments of the new WWW suggest a model for escaping the current dilemma many Internet companies face in attempting to generate revenue from their products and services.

The key is to tap user energy. If people feel they are getting something valuable, especially if it's something they willingly contribute to, they are very likely to pay for it, willingly. For this reason, sites such as Keen.com and Salesforce.com that built their businesses and their technology from the beginning with this in mind are continuing to grow towards profitability.

There are opportunities even for a service such as Web-based email, where there are dozens of competitors including players such as Yahoo! and Microsoft's Hotmail with tens of millions of accounts. Oddpost, created by two former employees of Web-application developer Halfbrain (SEE RELEASE 1.0, JANUARY 2000), uses DHTML to offer a remarkably desktop-like user interface. They are charging $30 per year, which seems reasonable for the functionality they offer. After all, plenty of people pay for cable even though broadcast TV is available for free.

The dilemma many Internet companies now find themselves in is that they are forced to squeeze blood from a stone. Having built services designed to be given away for free (perhaps recouped through advertising), they are now struggling to convince users they should pay for the privilege.

The current wave of Web services, Weblog and WiFi experimentation suggests a number of potential business models. Google and Amazon don't charge today for use of their APIs. We're at the early stages of the demand curve, with usage patterns uncertain. Google and Amazon benefit from the additional traffic and customer lock-in their APIs generate, even if they don't get revenue directly.

Sooner or later, though, someone will create a service based on the Google and Amazon APIs that they – or their customers – are willing to pay for. It might be a competitive intelligence service, a comparison-shopping engine, or something we can't even envision. At that point, Amazon and Google can charge for "premium" access to their data and application functionality.

The Google and Amazon APIs are effectively "self-service" versions of the platform services those companies already provide. Amazon generates over $100 million in annual revenue providing the e-commerce engine for other companies such as Borders, Toys 'R Us and Target. Google integrates its search engine into portals such as Yahoo! The APIs open up a new market for situations where such high-end, custom deals don't make sense.

Something for everyone

Not everyone is Google or Amazon. Market leaders have more leeway to generate revenues through open interfaces, because others already see them as a standard platform. Still, there are plenty of opportunities for smaller or newer players. In the Weblog world, Pyra (the makers of Blogger) and Userland charge for their "pro" software. In WiFi, Boingo and Joltage (SEE RELEASE 1.0, MARCH 2002) are aggregating access points and charging for virtual ISP services. And these are just the beginning.

A common assumption is that the Net fosters "winner-take-all" markets, because of the network effects that make leaders even more successful. A new study of Web links by researchers at NEC, however, suggests that isn't always the case.

Link structure on the Web as a whole follows a "power law," meaning that a very small number of sites have an extremely large number of links pointing to them, while the vast majority of sites have few inbound links. Within categories such as sports, health, and home & garden, however, the NEC study found a flatter distribution. In other words, the most successful sites don't necessarily suck up all the traffic.

The land-grab metaphor for Internet-based businesses was too simplistic. Fortunately, there are alternative models. Syndication (SEE RELEASE 1.0, JULY/AUGUST 1999) remains a good way to understand the emergent business paradigm of the Web. Companies can play several roles – originators, syndicators and distributors – and they can do so for several types of resources – content, commerce and applications. Web services, Weblogs and WiFi provide new mechanisms for those relationships.

The World Wide Web as a mass phenomenon is eight years old. Time Berners-Lee created its protocols *thirteen* years ago. It's time for a new wave of technology, and of people, to take the Web to the next level. Keep your eye on the leading edge. ■ R 1.0

COMING SOON

- Who controls the Net?
- Grid computing.
- Large-group collaboration.
- The standards game.

- And much more. . . (If you know of any good examples of the categories listed above, please let us know.)

Resources & Contact Information

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For further reading:
David Isenberg & David Weinberger, "The Paradox of the Best Network," http://netparadox.com/
Tim O'Reilly, "Inventing the Future," http://www.oreillynet.com/pub/a/network/2002/04/09/future.html
Esther Dyson, "Parallel Channel,"
http://www.edventure.com/conversation/article.cfm?Counter=8648145
Kevin Kelly, "Where Music Will Be Coming From," New York Times Magazine, March 17, 2002
David Pennock et al, "Winners don't take all: Characterizing the competition for links on the Web,"
http://modelingtheweb.com

Calendar of High-Tech Events

	2002
MAY 7-11	**WWW 2002** - Honolulu, HI. The Eleventh World Wide Web Conference, organized by the World Wide Web Consortium. For more information, email info@www2002.org. www.www2002.org
MAY 12-17	**2002 World Congress on Computational Intelligence** - Honolulu, HI. Three inter-related conferences: International Joint Conference on Neural Networks; IEEE International Conference on Fuzzy Systems; and Congress on Evolutionary Computation. www.wcci2002.org
MAY 13-16	**O'Reilly Emerging Technology Conference** - Santa Clara, CA. P2P, Web Services, wireless, and beyond, with the theme of "building the Internet operating system." Featuring Lawrence Lessig, Rick Rashid and Steven Johnson. Register on the Web or call 1 (707) 829-0515); fax, 1 (707) 823-9746. conferences.oreilly.com/etcon/
MAY 19-21	**Vortex 2002** - Dana Point, CA. The annual event, now under the direction of John Gallant, brings together the telecommunications, Internet, and data-networking industries to discuss the future of network infrastructure. Register online. www.edgconferences.com/vortex/VwE2B
MAY 20	**Global Wireless Summit** - New York, NY. For carriers, content and service providers, hardware and software manufacturers in the wireless industry. Topics include next-generation infrastructure, mobile entertainment and information services. Speakers include Nobuharu Ono, President & CEO, NTT DoCoMo USA. Presented by Consect and the Japan Society. For more information or to request an invitation, email wirelessummit@consect.com. http://consect.com/GWS2002.html K
MAY 29-30	**RSA Conference 2002** - Tokyo, Japan. Feeling insecure? Corporate security experts, mathematics and cryptography researchers examine Internet telecommunications technology, privacy issues, and e-business security. For information, call +81(3)5549-1313 or email rsa-s@key3media.co.jp. www.rsaconference.com
JUNE 10-12	**802.11 Planet Spring 2002** - Philadelphia, PA. See why and how unlicensed wireless is taking off and changing the nature of connectivity. Organized by INT Media Group. Contact Allison Alessio at registration@internet.com or 1 (203) 662-2857. http://www.intmediaevents.com/80211/spring02/ K
JUNE 17-18	**WSJ Europe's 9th Annual CEO Summit** - Paris, France. The premier Dow Jones Conference for global industry leaders. Looks at the changing face of Europe's technology landscape. Register online or contact Maxine Berry, +44 (0)20 7842-9679. www.djconferences.dj.com

E Events Esther plans to attend.
K Events Kevin plans to attend.

Lack of a symbol is no indication of lack of merit. The full, current calendar is available on our Website, www.edventure.com. Please contact Irene Lawrence (irene@edventure.com) to let us know about other events we should include.

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